FINAL REPORT DATA MANAGEMENT STUDY APPENDIX O CONTRACTOR DATA REQUIREMENTS SCIENCE INTEGRATION (SI)

PREPARED BY:

APPROVED BY :

W.J. Roths
Manager, Systems Engineering
Voyager Spacecraft System Project

A. FRANK, COGNIZANT ENGINEER

DATA MANAGEMENT AND CONTROL TASK

VOYAGER SPACECRAFT SYSTEM PROJECT

J.H. BEHM
PROJECT ENGINEER, DATA MANAGEMENT
VOYAGER SPACECRAFT SYSTEM PROJECT

Prepared for
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NASA Pasadena Office
Pasadena, California

UNDER NASA CONTRACT No. NAS7-584



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INTRODUCTION

1.1 DEFINITION - SCIENCE INTEGRATION (SI)

This category includes data used to plan, control, review, and report Voyager activities relative to the selection, preparation, conduct, and interpretation of scientific experiments.

1.2 SCOPE

Data items include the specifications, reports, lists, guidelines, and manuals required to successfully integrate the GFE experiments on the spacecraft.

The contractor - user flow diagrams show the principal design and development control activities associated with the contractor engineering effort. Emphasis is placed upon the actions and documents required in designing the spacecraft to meet the structural and electrical requirements and in handling the processing, storage, and communication of scientific data. The project span covered by the flow diagrams extends from contract award through the Mission Acceptance Review. The diagrams have been prepared with the assumption that the GFE scientific experiments information and hardware will be available at the times shown.

DATA ITEM NUMBER	DATA ITEM SCIENCE INTEGRATION	DESCRIPTION
SI- 001	Specification, Spacecraft Science Integration	Specific performance and design requirement ments on the spacecraft. Defines the interfascience subsystem.
SI- 002	Specification, Spacecraft Science OSE	Specifies performance and design requireme
SI- 003	Report, Science Analysis and Trade Study	Report on science analysis; alternate approastallation operation, and calibration.
SI- 004	Specification, Scientific Instrument Requirements	Specifies requirements for the combined gro items as (but not limited to): electrical powe events, telemetry channel assignments, mea
SI- 005	Report, Science Checkout and Evaluation	Reports of operation status of science equipmenters.
SI- 006	Specification, Science Standards Requirements	Summary description of characteristics of al
SI- 007	List, Science Parts	Tabulation of all component parts required for Includes both GFE and contractor-furnished
SI- 008	Report, Science Qualification Tests	Reports of status of experiments after being Includes analysis of problems, causes and problems.
SI- 009	Specification, Configuration Management Requirements (Experiments)	Establishes information expected by spacecr experimenters.
SI- 010	Manual, Science Calibration (Preflight and Flight)	An approved set of procedures for calibratin

DATA ITEM LIST/USER MATRIX

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USER FLOW DIAGRAMS

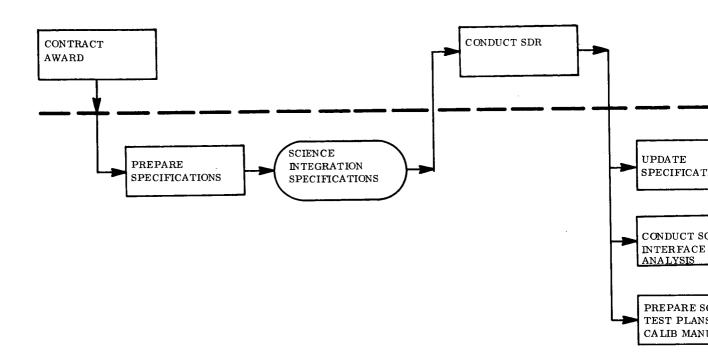
Contractor - user flow diagrams show the relationship between Voyager system documentation and the activities undertaken by the prime spacecraft contractor. The diagrams are intended to be a communication tool which describes the project in terms which emphasize documentation and as a planning tool for the integration of data management activities into the overall project management scheme.

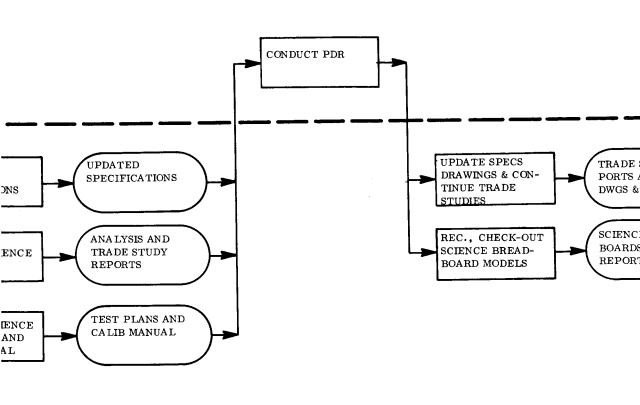
The project is considered in a generalized sense, in that subsystems and components are each treated as collective entities; that is, the documentation flows associated with the several separate subsystems are not distinguished. A single representative flow is presented.

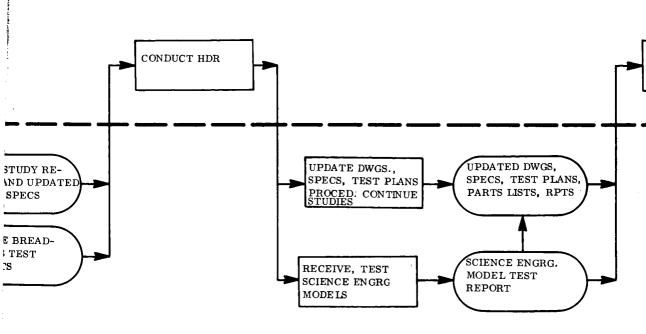
The drawings show the detail activities and are keyed to the formal design and hardware reviews. A generalized summary flow is also included.

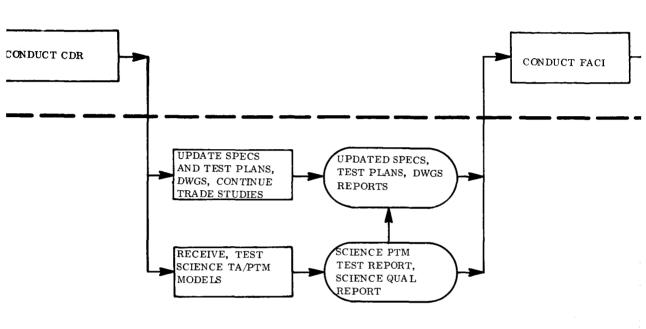
Science Integration User Flow Diagrams

Figure Number	Title
O-1	Science Integration User Flow Diagram - Summary
O-2	Science Integration User Flow Diagram - Contract Award Through Preliminary Design Review
O - 3	Science Integration User Flow Diagram - Preliminary Design Review Through Critical Design Review
O-4	Science Integration User Flow Diagram - Critical Design Review Through Mission Acceptance Review









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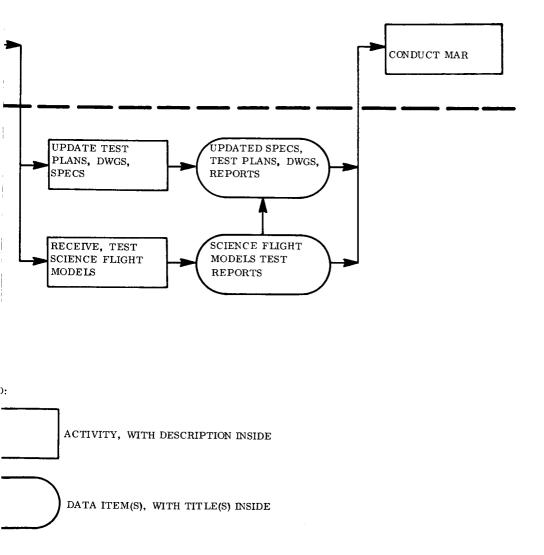
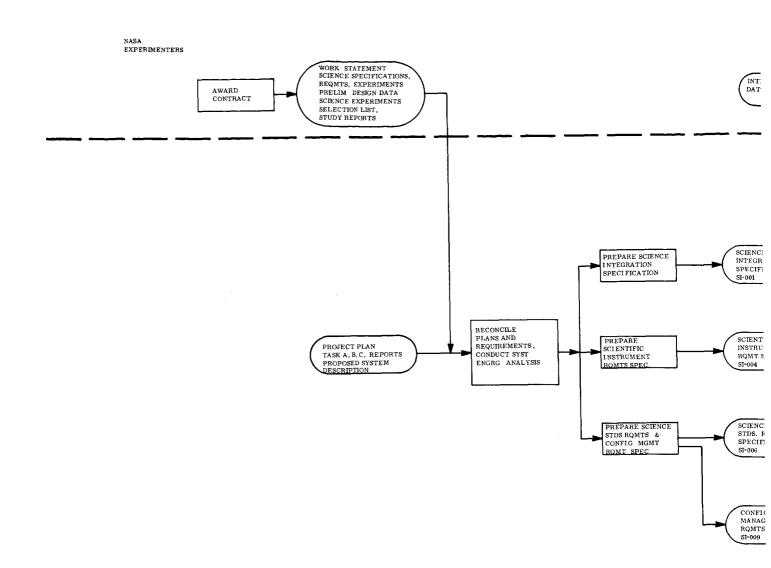
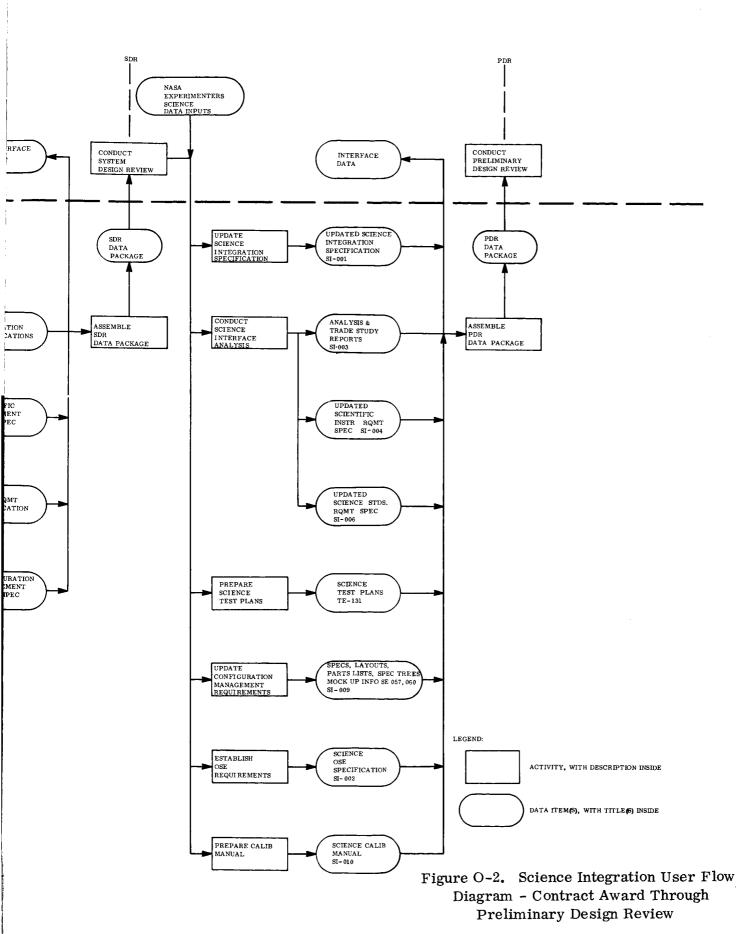
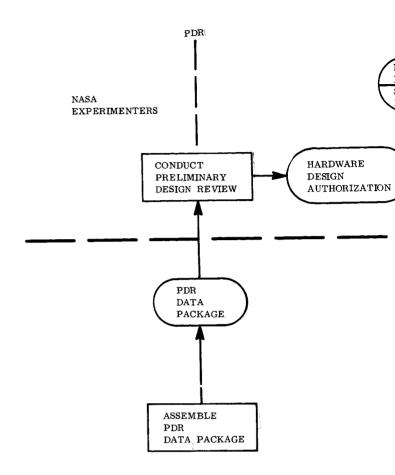


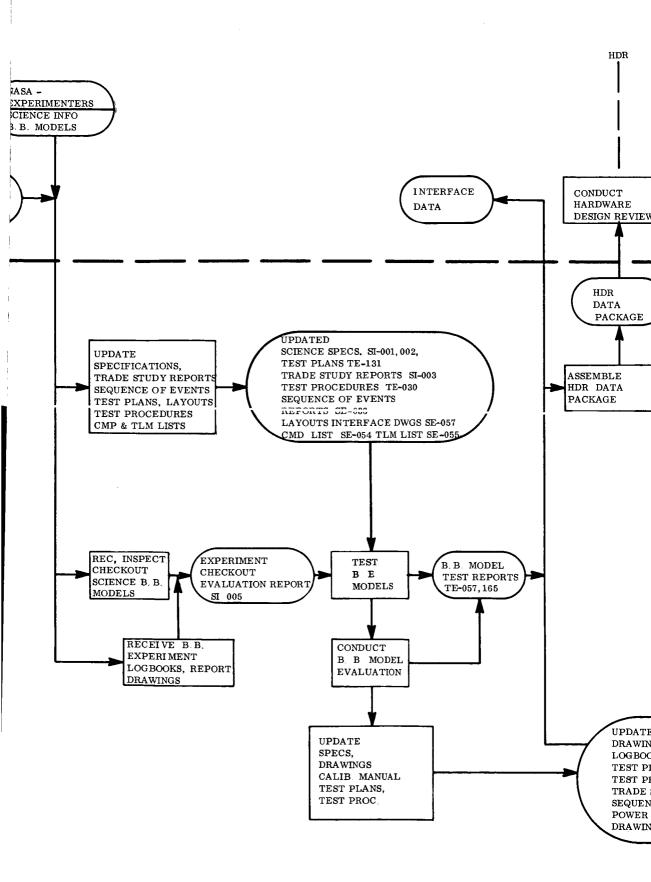
Figure O-1. Science Integration User Flow Diagram (Summary)

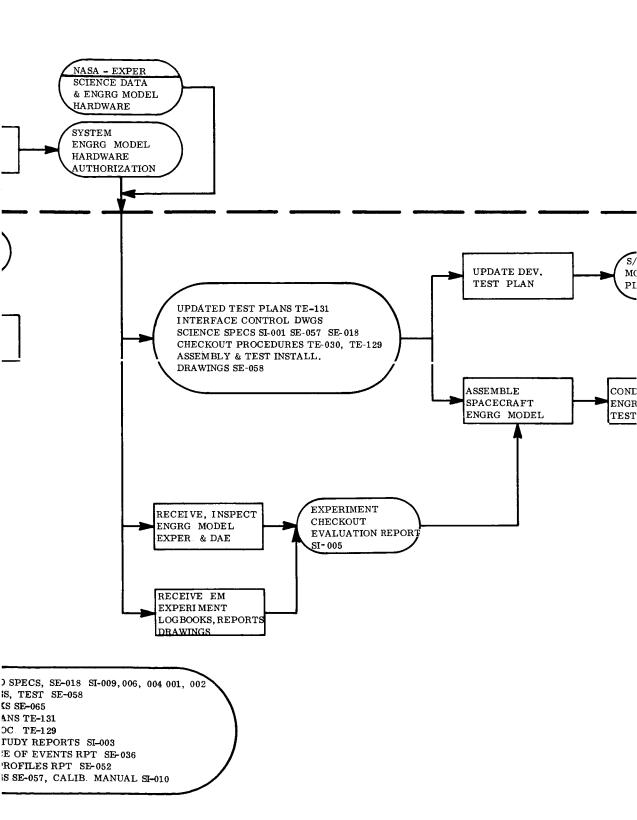
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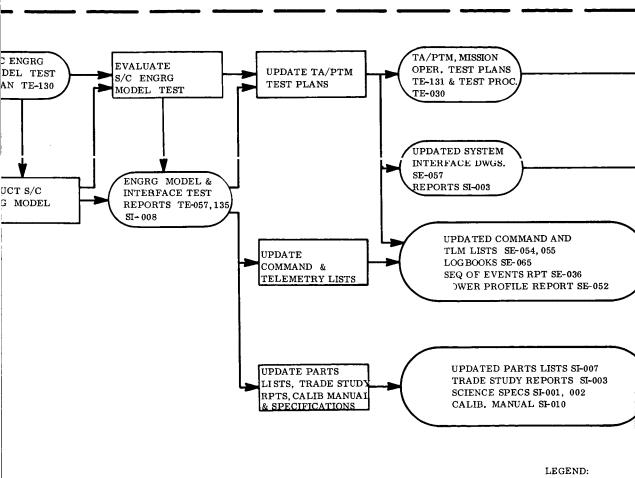








INTERFACE DATA



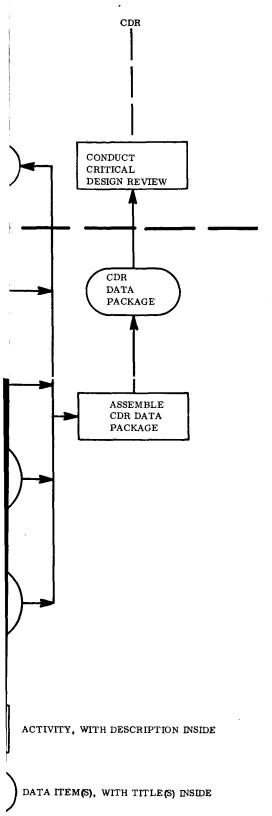
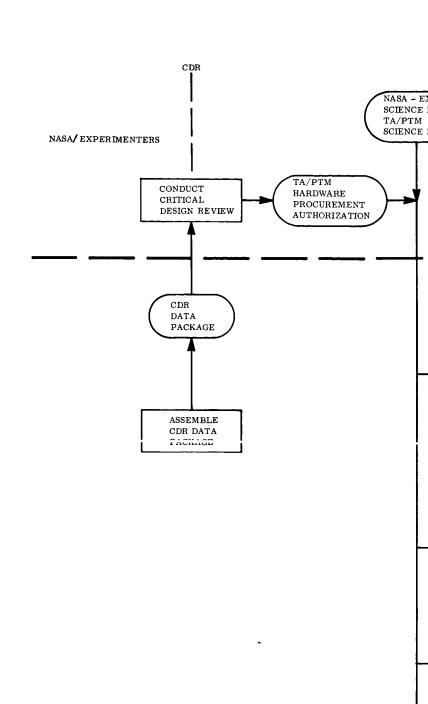


Figure O-3. Science Integration User Flow Diagram - Preliminary Design Review Through Critical Design Review



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SE-057, 068

DESIGN RPT SE-047, SI-009

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CHECKOUT TA/PTM

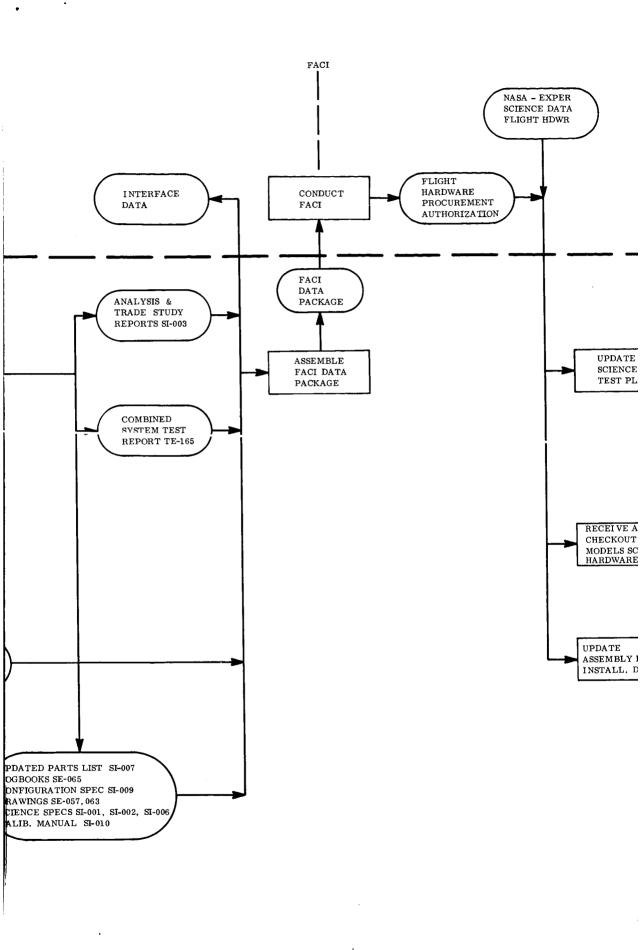
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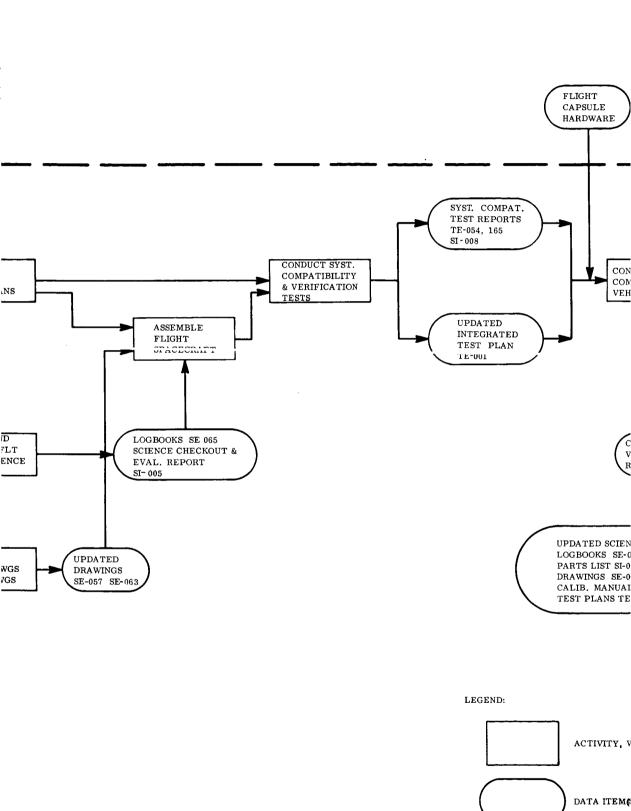
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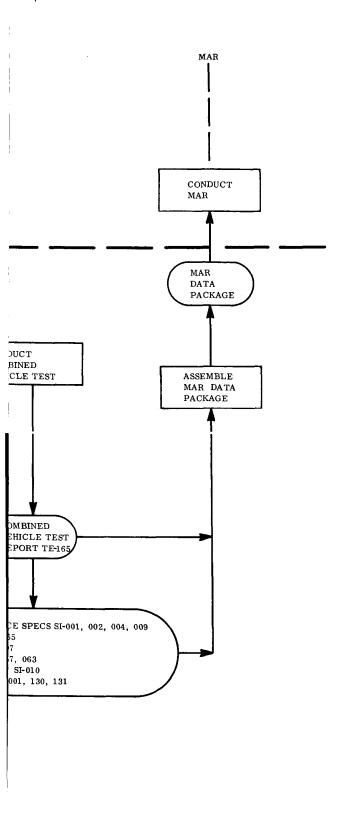
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Figure O-4. Science Integration User Flow Diagram - Critical Design Review Through Mission Acceptance Review



Science Integration Data Requirement Descriptions

DRD	
Number	Title
SI-001	Specification, Spacecraft Science Integration
SI-002	Specification, Spacecraft Science OSE
SI-003	Report, Science Analysis and Trade Study
SI-004	Specification, Scientific Instrument Requirements
SI-005	Report, Science Checkout and Evaluation
SI-006	Specification, Science Standards Requirements
SI-007	List, Science Parts
SI-008	Report, Science Qualification Tests
SI-009	Specification, Configuration Management Requirements (Experiments)
SI-010	Manual, Science Calibration (Preflight and Flight)

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APPROVAL TO: Project Manager BY

VOYAGER DATA REQUIREMENT DESCRIPTION - 2ND SHEET

specifications: Documents to be based upon the contract work statement, customer specifications, requirements, experiments preliminary design data, science experiments selection list, and experimenters' study reports issued at time of contract award. This document shall be completed, updated and reissued as required prior to each design review.

DRD NO.: SI-001

This specification will be prepared jointly by the contractor and the NASA Center with assistance from the experimenters. It is a directive document in that it establishes the design requirements of the spacecraft as affected by each experiment.

SPECIAL DISTRIBUTION: (IF DISTRIBUTION IS NOT COVERED BY AN EXISTING DDL WRITE IN DISTRIBUTION BELOW)

OUTLINE OF CONTENTS:

- 1. Scope
- 2. Applicable documents
- 3. Requirements
 - a. Performance
 - (1) Characteristics
 - (2) Subsystem definition
 - (3) Operability
 - b. Data interface
 - c. Electrical interface
 - d. Mechanical interface
 - e. Thermal interface
 - f. Planetary scan platform and control experiment
 - g. Spacecraft body mounted experiments

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VOYAGER DATA REQUIREMENT DESCRIPTION - 2ND SHEET

SPECIAL INSTRUCTIONS: This document establishes the functional design requirements for the OSE associated with the scientific experiments when installed on the spacecraft. The first issue of this specification shall be made prior to PDR and shall be updated as required when more technical data on the experiments become available.

DRD NO.: SI-002

SPECIAL DISTRIBUTION: (IF DISTRIBUTION IS NOT COVERED BY AN EXISTING DDL WRITE IN DISTRIBUTION BELOW)

OUTLINE OF CONTENTS:

- 1. Scope
- 2. Applicable documents
- 3. Design requirements
 - a. Performance
 - (1) Characteristics
 - (2) Component definition and description
 - (3) Operability
 - b. Design and construction
 - (1) Data interface
 - (2) Electrical interface
 - (3) Mechanical interface

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VOYAGER DATA REQUIREMENT DESCRIPTION - 2ND SHEET

a form that quantitative information can be obtained directly from them; i.e., graphs shall be of sufficient size with sufficient grids such that points can be read directly from the graphs, and each graph, etc., shall be sufficiently labeled so as to be self-explanatory. Reports covering a single analysis are preferred to longer reports covering a variety of analyses.

The content of the report may consist of extracts from the experimenters' design data report and from the contractor's Science Integration engineers' notebook, contractor's internal memorandums, minutes of meetings, reduction of presentation charts and formal engineering reports, etc., as long as the study report contains as a minimum, the items shown below in the outline of contents. Each report on each experiment shall cover a complete analysis and shall be self-sufficient except for references to other formal documents.

SPECIAL DISTRIBUTION: (IF DISTRIBUTION IS NOT COVERED BY AN EXISTING DDL WRITE IN DISTRIBUTION BELOW)

OUTLINE OF CONTENTS:

- 1. Scope
- 2. Functional and technical design requirements
- 3. Design approaches and significant design characteristics
- 4. Comparison matrix of design approaches
- 5. Recommended design approach

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VOYAGER DATA REQUIREMENT DESCRIPTION - 2ND SHEET

SPECIAL INSTRUCTIONS: These specification appendixes shall be continually updated to include computer printouts, with data describing individual science events recorded on the tabulating cards for ease of revision in order, duration, or time of occurence. Items to be covered are electrical power requirements, commands, telemetry channel assignments, measurements, and data handling information. Each Science data item shall contain:

- 1. Name of the experiment and its status, such as "off" or "on," etc.
- 2. The predicted nominal time of the execution of this event.
- 3. The source for the initiation of the event.
- 4. The backup source code or command number.
- 5. Type of output data required for each experiment.

SPECIAL DISTRIBUTION: (IF DISTRIBUTION IS NOT COVERED BY AN EXISTING DDL WRITE IN DISTRIBUTION BELOW)

OUTLINE OF CONTENTS:

- 1. Scope
- 2. Applicable documents
- 3. Description and explanation of notation
- 4. Notes used on tabulated sequence, commands, etc.

Appendix

- 1. Tabulated sequence of events and power profile
 - a. Nominal predicted mission
 - b. Alternate or degraded missions
- 2. Measurements
 - a. Body-mounted instruments
 - (1) Data types
 - (2) Data rates
 - b. Scan platform instruments
 - (1) Data types
 - (2) Data rates
- 3. Data modes and switching
- 4. Command list

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GE EXHIBIT DRD SI-005	
VOYAGER DATA REQUIREMENT DESCRIPTION - 2ND SHEET	
SPECIAL INSTRUCTIONS:	SI-005
This report will be used to give the contractor's initial evaluation of an operational test to be performed on each model of an experiment when it is received the spacecraft contractor from the experimenter.	by
SPECIAL DISTRIBUTION: (IF DISTRIBUTION IS NOT COVERED BY AN EXISTING DDL WRITE IN DISTRIBUTION BELOW)	

OUTLINE OF CONTENTS:

- 1. Introduction and Summary
 - a. What was tested
 - b. When the tests occurred
 - c. Where the tests were conducted
 - d. Major events, number of tests, length of test, etc.
- 2. Objectives and apparent degree of satisfaction
- 3. Evaluation of the test and data produced
- 4. Conclusions

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VOYAGER DATA REQUIREMENT DESCRIPTION - 2ND SHEET

SPECIAL INSTRUCTIONS:

DRD NO.: SI-006

This document will be used to define the scientific experiments, their physical characteristics and interfaces based upon information supplied by the customer.

In addition to containing a brief description of each experiment and a list of reference documents, it will summarize the characteristics of each experiment in tabular form.

SPECIAL DISTRIBUTION: (IF DISTRIBUTION IS NOT COVERED BY AN EXISTING DDL WRITE IN DISTRIBUTION BELOW)

OUTLINE OF CONTENTS:

- 1. Introduction
- 2. Experiment objectives and instrument descriptions
- 3. References
- 4. Appendix

Table I Body-mounted instruments

Table II Instruments on scan platform

(Each of these tables shall list the experiments and show for each one such characteristics as: sensor and electronics weight, sensor and electronics volume, power input, data rate, total field of view, alignment tolerance, orientation clock and cone angle, and general remarks)

(CONTINUE ON THIRD SHEET, IF NECESSARY, AND AFFIX TO THIS DRD.)

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SPECIAL INSTRUCTIONS:	DRD NO.: SI-007
This document will be a summary list of all science components on the spacecraft including those components furnished by both the customer and the spacecraft contractor.	
SPECIAL DISTRIBUTION: (IF DISTRIBUTION IS NOT COVERED BY AN EXISTING DDL WRITE IN DISTRIBUTION BELOW)	
OUTLINE OF CONTENTS: This document will be in the form of a matrix and will contain at least the following information about each Science component:	
1. Component name	
2. Experiment name	
3. Quantity used	
4. Name of supplier5. Supplier identification number	
6. Spacecraft contractor identification number	

(CONTINUE ON THIRD SHEET, IF NECESSARY, AND AFFIX TO THIS DRD.)

7. Contractor next assembly drawing number

8. Location of spacecraft

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SPECIAL INSTRUCTIONS:	DRD NO
This report is used to summarize the status of the experiments after being tested in	

This report is used to summarize the status of the experiments after being tested in the engineering model, PTM, and flight spacecrafts. The analysis of the problems, causes, and prevention will include a comparison with data received from the experimenters and with test data obtained when experiments are initially checked out individually by the spacecraft contractor.

SPECIAL DISTRIBUTION: (IF DISTRIBUTION IS NOT COVERED BY AN EXISTING DDL WRITE IN DISTRIBUTION BELOW)

OUTLINE OF CONTENTS:

- 1. Scope
- 2. Applicable documents
- 3. Summary of test results of experiments while operating in spacecraft
- 4. Analysis of problems
- 5. Notes
- 6. Appendix

(CONTINUE ON THIRD SHEET, IF NECESSARY, AND AFFIX TO THIS DRD.)

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VOYAGER DATA REQUIREMENT DESCRIPTION - 2ND SHEET

SPECIAL INSTRUCTIONS:

DRD NO.: SI-009

This report will (1) establish the information expected by the spacecraft contractor from the experimenters, and (2) provide background information and instructions to contractor spacecraft system designers as to the selection of operational modes and parameters that will meet the constraints of the experiments in order to acquaint the personnel with the methods and approach for properly integrating the science subsystem.

SPECIAL DISTRIBUTION: (IF DISTRIBUTION IS NOT COVERED BY AN EXISTING DDL WRITE IN DISTRIBUTION BELOW)

OUTLINE OF CONTENTS:

- 1. Scope
- 2. Reference documents
- 3. Science subsystem constraints overall
- 4. Science subsystem constraints during operational phases
 - a. Prelaunch
 - b. Launch
 - c. Near-earth corrections
 - d. Interplanetary cruise
 - e. Near-Mars corrections/orbit insertion
 - f. Martian orbit maneuvers
- 5. Recommended approaches to fulfilling science constraints
- 6. Recommended modes of operation of experiments
- 7. Notes

(CONTINUE ON THIRD SHEET, IF NECESSARY, AND AFFIX TO THIS DRD.)

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VOYAGER DATA REQUIREMENT DESCRIPTION - 2ND SHEET
This document will contain an approved set of procedures for calibrating each experiment so that reliable data and confidence can be maintained during system test and during various phases of the planetary mission.
SPECIAL DISTRIBUTION: (IF DISTRIBUTION IS NOT COVERED BY AN EXISTING DDL WRITE IN DISTRIBUTION BELOW)
OUTLINE OF CONTENTS:
 Scope Applicable documents Step-by-step calibration procedure for each experiment Notes Appendix Calibration curves and tables as required.
(CONTINUE ON THIRD SHEET, IF NECESSARY, AND AFFIX TO THIS DRD.)

DOCUMENTATION RELATIONSHIP TREES

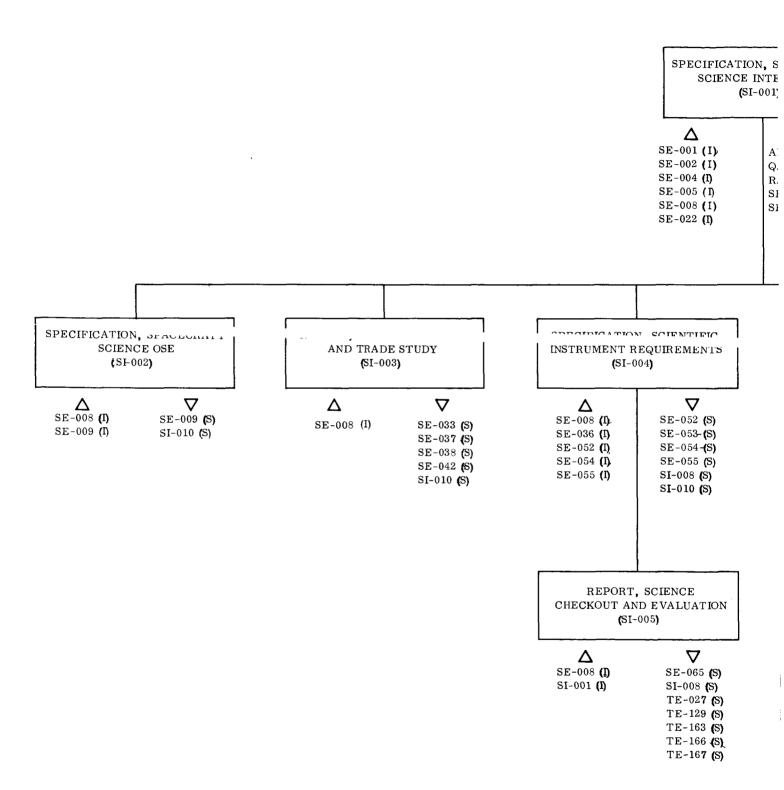
A documentation relationship tree has been prepared to further develop the data base interrelationships by identifying and presenting pictorially the relationships of all Voyager contractor data items within each functional category and by showing their relationships across categories.

Relationships within the functional category are shown by constructing a tier pattern beginning with the top-level (or governing) data item and relating, in descending order, all data items within the category to this top-level data item. (The location of a data item at a given level on the diagram does not necessarily indicate the importance of that specific item but identifies and defines its relation to all other data items in that category.)

Relationships between data items in one category and data items in other functional categories are shown by (1) arrows to indicate the direction of the relationship, and (2) an alphabetic code to indicate the nature of the interrelationship as follows:

- a. Data items needed for preparation and/or support of the referenced item. (I)
- b. Data items supported or needed by this data item. (S)
- c. Data items that relate "to" and provide information of a general nature but are not required in an input or support role. (G)

Each data item appearing on the Data Item List (DIL) was examined and evaluated with respect to its contribution to, or dependence on, data items appearing in other categories, and is included in the diagrams.



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A-009 (S) TE-001 (S)
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C-007 (S) TE-130 (S)
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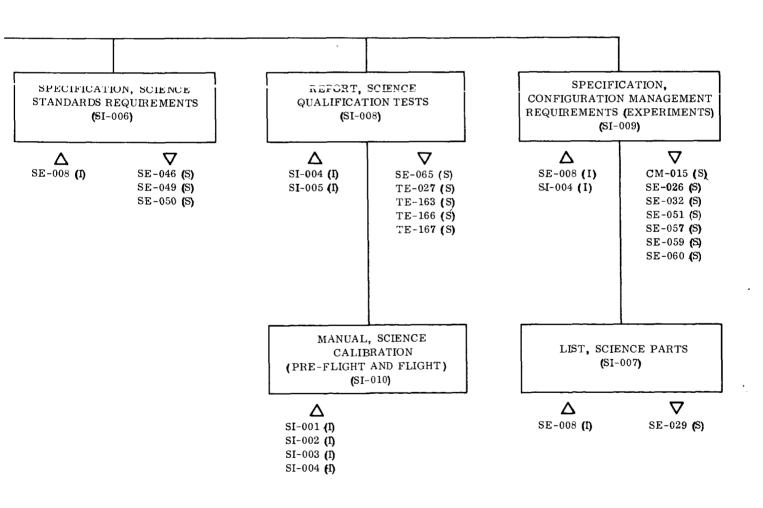


Figure O-5. Science Integration Documentation Relationship Tree (SI)

DATA ITEM PHASING/FREQUENCY

The data item frequency and phasing chart shows the requirements for contractor data item preparation by major project review periods. It is concerned with the phasing and frequency of preparation of each individual data item and not the total number of copies required for reproduction and distribution.

The following legend and/or abbreviations have been used:

Α	Annual	Q	Quarterly
S/A	Semiannual	I	Initial
WK	Weekly	F	Final
MO	Monthly	N/R	New and revised
B/W	Biweekly	SDR	System design review
B/M	Bimonthly	PDR	Preliminary design review
O/T	One time	HDR	Hard design review
A/R	As required	CDR	Critical design review
U	Update	FACI	First article configuration
I/U	One update		inspection
DA	Daily	MAR	Mission acceptance review
		J FACT	Joint flight acceptance composite testing



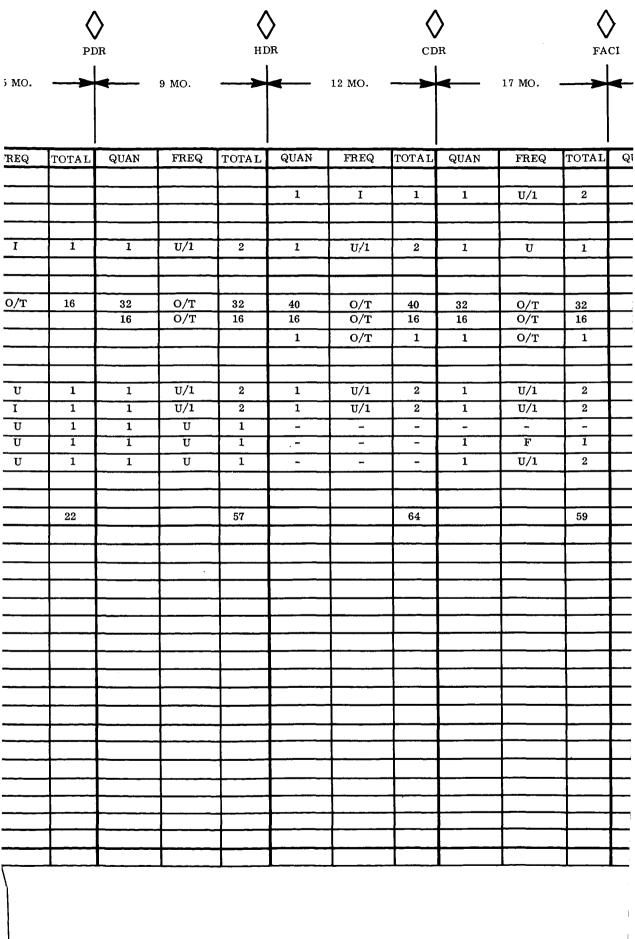
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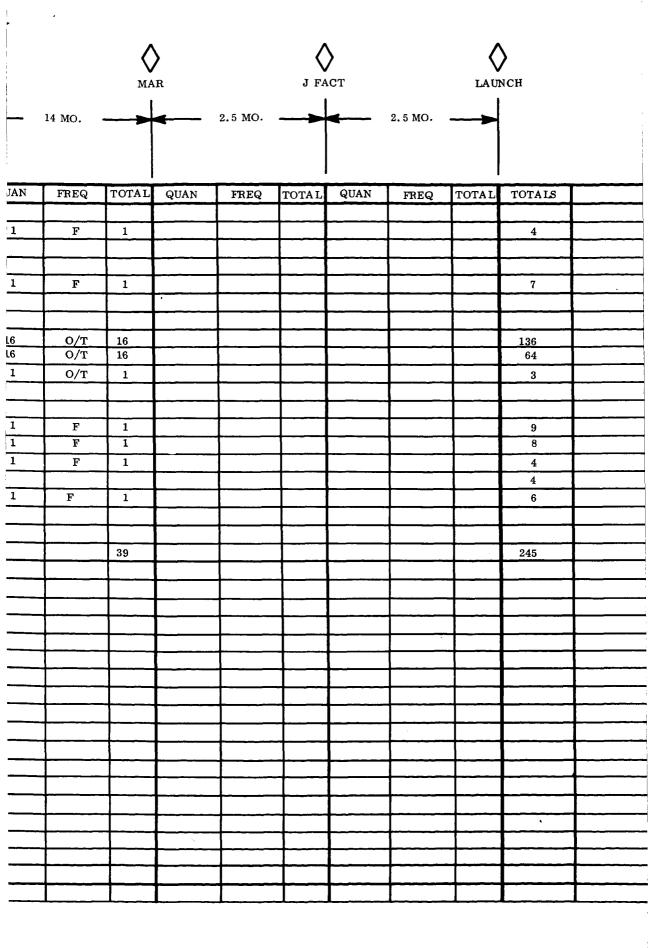
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DATA ITEM TITLE

COTENIOR	INTEGRATION	

SCIENCE INTEGRATION	1		ļ.		
BOILINGS ENTERED	QUAN	FREQ	TOTAL	QUAN	
LISTS					Γ
SI-007 List, Science Parts					
MANUALS					
SI-010 Manual, Science Calibration (Pre-Flight and Flight)				1	L
					L
REPORTS					L
SI-003 Report, Science Analysis and Trade Study	<u> </u>			16	Ļ
SI-005 Report, Science Checkout and Evaluation					L
SI-008 Report, Science Qualification Tests	ļ				Ļ
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SPECIFICATIONS		<u> </u>	4		Ł
SI-001 Specification, Spacecraft Science Integration	1	I	1	1	Ļ
SI-002 Specification, Spacecraft Science OSE	,	 		1	╀
SI-004 Specification, Scientific instrument requirements	1	T	1 1	i 1	1
SI-006 Specification, Science Standards Requirements		 	1	1	╁
SI-009 Specification, Configuration Management Requirements (Experiments)	1	I	 		╀
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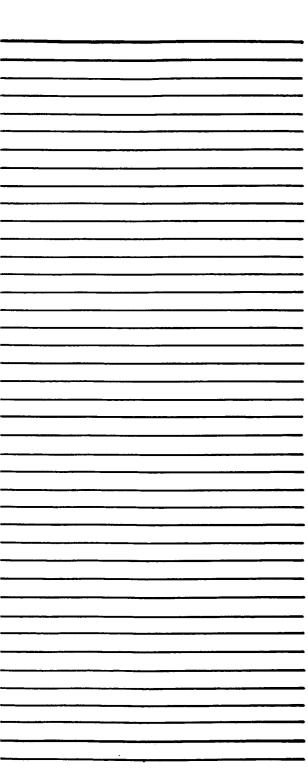


Figure O-6. Science Integration Data Item
Phasing and Frequency Matrix